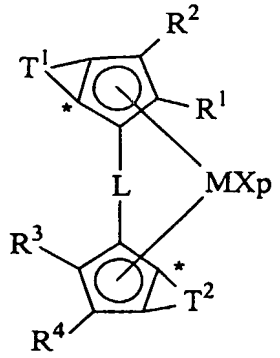
Claims

1. A process for preparing isotactic 1-butene copolymers containing up to 30% by mol of units derived from one or more alpha olefins of formula CH_2=CHZ, wherein Z is a C_3-C_{20} hydrocarbon group comprising contacting 1-butene and one or more of said alpha-olefins, under polymerization conditions, in the presence of a catalyst system obtainable by contacting:

a) at least a metallocene compound of formula (I)



(I)

wherein

M is a transition metal belonging to group 3, 4, 5, 6 or to the lanthanide or actinide groups in the Periodic Table of the Elements;

p is an integer from 0 to 3, being equal to the formal oxidation state of the metal M minus 2;

X, equal to or different from each other, are hydrogen atoms, halogen atoms, or R, OR, OSO_2CF_3, OCOR, SR, NR_2 or PR_2 groups, wherein R is a linear or branched, saturated or unsaturated C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} alkylaryl or C_7-C_{20} arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; or two X can optionally form a substituted or unsubstituted butadienyl radical or a OR'O group wherein R' is a divalent radical selected from C_1-C_{20} alkylidene, C_6-C_{40} arylidene, C_7-C_{40} alkylarylidene and C_7-C_{40} arylalkylidene radicals;

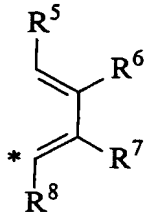
L is a divalent bridging group selected from C_1-C_{20} alkylidene, C_3-C_{20} cycloalkylidene, C_6-C_{20} arylidene, C_7-C_{20} alkylarylidene, and C_7-C_{20} arylalkylidene radicals optionally containing heteroatoms belonging to groups 13-

17 of the Periodic Table of the Elements, and silylidene radical containing up to 5 silicon atoms;

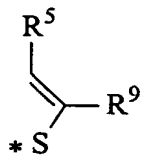
R^1 and R^3, equal to or different from each other, are linear or branched, saturated or unsaturated C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} alkylaryl or C_7-C_{20} arylalkyl radicals, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

R^2 and R^4, equal to or different from each other, are hydrogen atoms or linear or branched, saturated or unsaturated C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} alkylaryl or C_7-C_{20} arylalkyl radicals, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

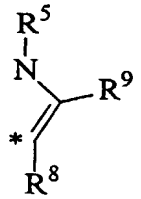
T^1 and T^2, equal to or different from each other are a moiety of formula (II), (III) or (IV):



(II)



(III)



(IV)

wherein: the atom marked with the * is bound to the atom marked with the same symbol bonds in formula (I);

R^5, R^6, R^7, R^8 and R^9, equal to or different from each other, are hydrogen atoms, or a linear or branched saturated or unsaturated C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_6-C_{40}-aryl, C_7-C_{40}-alkylaryl, C_7-C_{40}-arylalkyl radicals, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

R^6 and R^7 can also join to form a saturated or unsaturated condensed 5 to 7 membered ring optionally containing heteroatoms belonging to groups 13-16 of the Periodic Table of the Elements; and

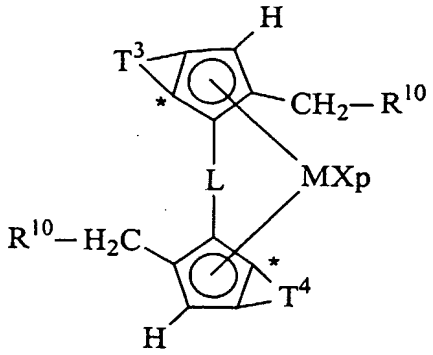
b) at least an alumoxane or a compound able to form an alkylmetallocene cation.

2 The process according to claim 1 wherein the catalyst system further comprises organo aluminum compound.

3 The process according to claim 1 or 2 wherein in the compound of formula (I) M is titanium, zirconium or hafnium; X is a hydrogen atom, a halogen atom or a R group; L is selected from the group consisting of is $Si(CH_3)_2$, $SiPh_2$, SiPhMe, $SiMe(SiMe_3)$, CH_2,

$(CH_2)_2$, $(CH_2)_3$ and $C(CH_3)_2$ and R^9 is a hydrogen atom or a linear or branched saturated or unsaturated C_1-C_{20}-alkyl radical.

4 The process according to anyone of claims 1 to 3 wherein the metallocene compound has formula (V):

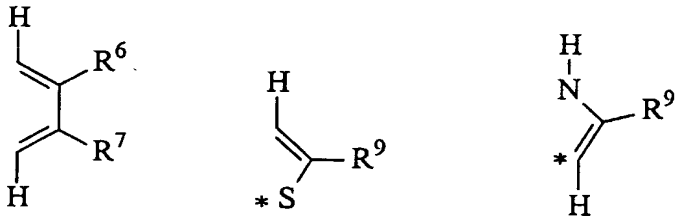


(V)

wherein M, L, X and p have the same meaning as in claim 1;

R^{10}, equal to or different from each other, are hydrogen atoms, or linear or branched saturated or unsaturated C_1-C_{19}-alkyl, C_3-C_{19}-cycloalkyl, C_6-C_{19}-aryl, C_7-C_{19}-alkylaryl, C_7-C_{19}-arylalkyl radicals, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

T^3 and T^4, equal to or different from each other are moieties of formula (Va), (Vb) or (Vc):



(Va) (Vb) (Vc)

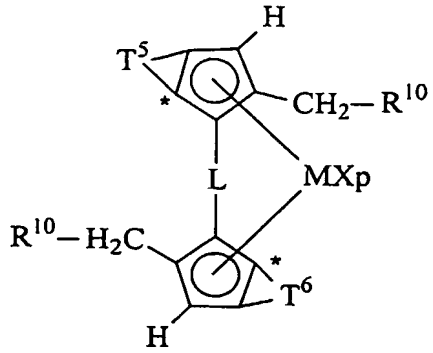
wherein: the atom marked with the symbol * is bound to the atom marked with the same symbol in formula (V);

R^6, R^7 and R^9 have the same meaning as in claim 1.

5 The process according to claim 4 wherein in the compound of formula (V) R^{10} is a hydrogen atom or a C_1-C_{19}-alkyl radical; R^6, R^7 are hydrogen atoms or linear or branched saturated or unsaturated C_1-C_{20}-alkyl radicals, or they can form a saturated or unsaturaded 5 or 6 membered ring optionally containing heteroatoms heteroatoms

belonging to groups 13-16 of the Periodic Table of the Elements; and R^9 is a linear or branched saturated or unsaturated C_1-C_{20}-alkyl radical.

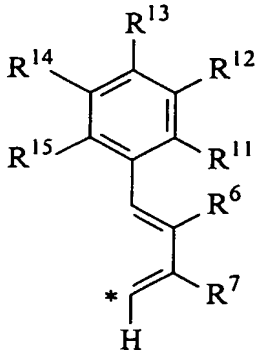
6 The process according to anyone of claims 1 to 3 wherein the metallocene compound has formula (VI):



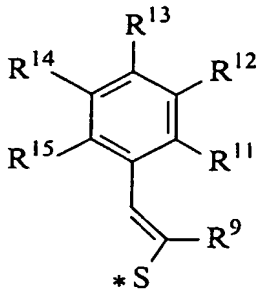
(VI)

wherein M, L, X and p have the same meaning as in claim 1 and R^{10}, equal to or different from each other, are hydrogen atoms, or linear or branched saturated or unsaturated C_1-C_{19}-alkyl, C_3-C_{19}-cycloalkyl, C_6-C_{19}-aryl, C_7-C_{19}-alkylaryl, C_7-C_{19}-arylalkyl radicals, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

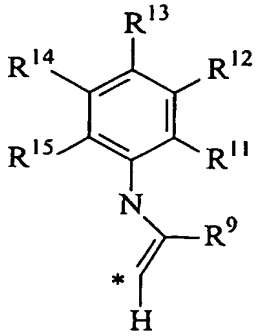
T^5 and T^6, equal to or different from each other are a moieties of formula (VIa), (VIb) or (VIc):



(VIa)



(VIb)



(VIc)

wherein: the atom marked with the symbol * is bound to the atom marked with the same symbol in formula (VI);

R^6, R^7 and R^9, have the same meaning as in claim 1;

R^{11}, R^{12}, R^{13}, R^{14}, and R^{15}, equal to or different from each other, are hydrogen atoms or linear or branched saturated or unsaturated C_1-C_{20}-alkyl, C_3-C_{20}-cycloalkyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl, C_7-C_{20}-arylalkyl radicals, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, or two adjacent groups can form together a saturated or unsaturated condensed 5 or 6 membered ring optionally containing heteroatoms belonging to groups 13-16 of the Periodic Table of the Elements.

7 The process according to claim 6 wherein R^6, R^7 are hydrogen atoms or linear or branched saturated or unsaturated C_1-C_{20}-alkyl radicals; or they can form a saturated or unsaturaded 5 or 6 membered ring optionally containing heteroatoms heteroatoms belonging to groups 13-16 of the Periodic Table of the Elements; R^9 is a hydrogen atom or a linear or branched saturated or unsaturated C_1-C_{20}-alkyl radical; R^{11} is a C_1-C_{20}-alkyl radical; R^{14} is a hydrogen atom or a C_1-C_{20}-alkyl radical; and R^{12}, R^{13} and R^{15} are hydrogen atoms.

8 The process according to anyone of claims 1 to 7 wherein the alpha-olefin is 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene, 4,6-dimethyl-1-heptene, 1-decene, 1-dodecene, 1-tetradecene, 1-hexadecene, 1-octadecene and 1-eicosene.

9 The process according to claim 8 wherein the alpha-olefin is comonomers are - 1-pentene, 1-hexene and 1-octene.

10 The process according to anyone of claims 1 to 9 wherein the content of said alpha olefins derived units in the copolymer is from 2% to 20% by mol.

11 An isotactic 1-butene copolymer containing up to 30% by mol of one or more alpha-olefins of formula CH_2=CHZ derived units, wherein Z is a C_3-C_{20} hydrocarbon group having the following features:

- isotactic pentads (mmmm) >90%; and
- the percentage of soluble fraction in diethylether (%SD) and the molar content of said alpha olefins (%O) in the polymer chain meet the following relation:

$$\%SD > 2.8\%O + 8.$$

12 The isotactic 1-butene copolymer according to claim 11 wherein the percentage of soluble fraction content in diethylether (%SD) and the molar content of said alpha olefins (%O) in the polymer chain meet the following relation:

$$\%SD > 2.8\%O + 10.$$

13. The isotactic 1-butene copolymer according to claims 11 or 12 having a content of alpha-olefin derived units comprised between 10% and 30% by mol and having percentage of soluble fraction in diethylether >92%.
14. The isotactic 1-butene copolymer according to claims 11 or 12 having a content of alpha-olefin derived units comprised between 5% and 12% by mol and having percentage of soluble fraction in diethylether >41%.
15. An isotactic 1-butene copolymer containing up to 30% by mol of units derived from one or more alpha-olefins of formula CH_2=CHZ, wherein Z is a C_3-C_{20} hydrocarbon group having the following features:
    - isotactic pentads (mmmm) >90%; and
    - presence of 4,1 insertions in the polymer chain.